UM0882
User manual

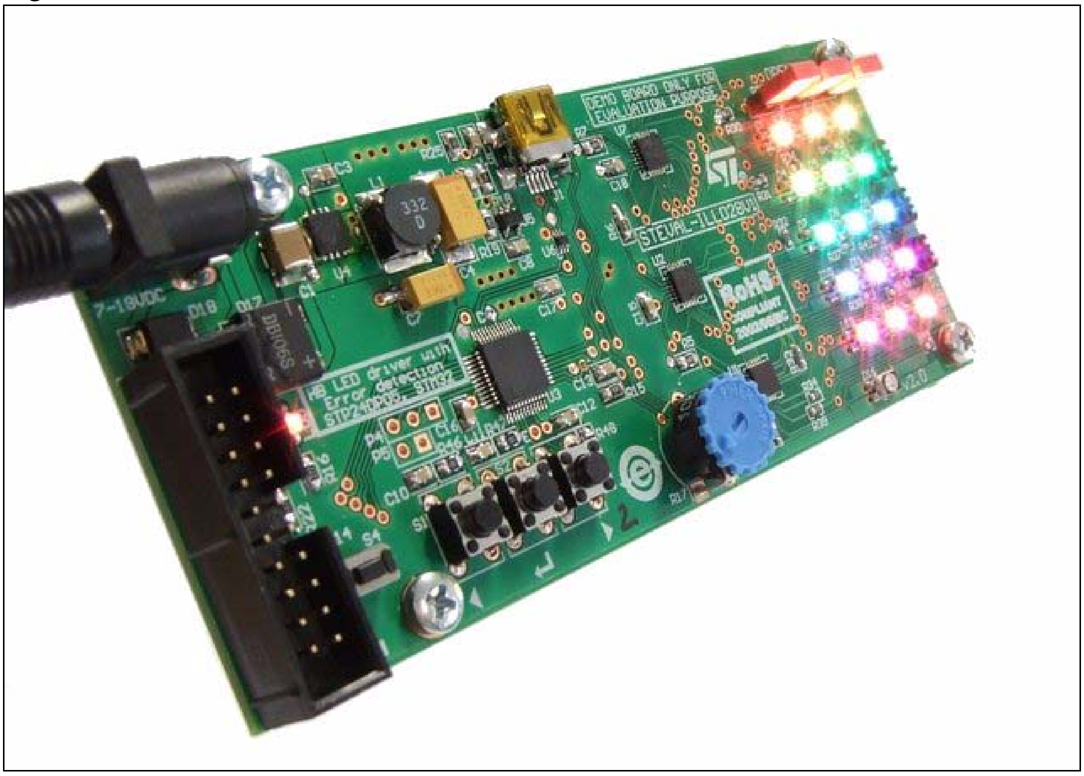
STEVAL-ILL028V1 LED dimmer board using STP1612PW05 and STM32™

1 Introduction

This user manual describes STMicroelectronics™ STEVAL-ILL028V1 LED dimmer board. This board is based on STP1612PW05 independent PWM LED driver controlled through STM32 microcontroller SPI interface and DMA (optional).

This document explains how to use the board: hardware setup, demonstration firmware functions, possible interconnections with PC and evaluation of STP1612PW05.

Figure 1. STEVAL-ILL028V1 LED dimmer board



Contents

1 Introduction 1

2 Board function overview 5

3 Hardware setup 6

3.1 Power supply 6

3.2 Microcontroller JTAG 6

3.3 Microcontroller clock, reset, USB clock 6

3.4 Jumpers for LED failure simulation 6

4 Description of the demonstration firmware functions 7

4.1 Mode “A” - interactive demonstration - color Tetris 8

4.2 Mode “B” - wave color demonstration 8

4.3 Mode “C” - solid color demonstration 8

4.4 Mode “D” - error detection 8

5 PC demonstration firmware software 9

6 Schematics 13

7 Bill of material 17

8 Revision history 19

List of tables

Table 1. Bill of material 17
Table 2. Document revision history 19

List of figures

Figure 1. STEVAL-ILL028V1 LED dimmer board 1
Figure 2. Setup of the board 6
Figure 3. The menu; the letter “A” indicates the first item of the menu 7
Figure 4. The control buttons 7
Figure 5. Simulation of LED defect by setting/removing P21 to P2 jumpers 8
Figure 6. Software - Windows® application 9
Figure 7. USB host (PC) detection in progress 10
Figure 8. USB host (PC) detected 10
Figure 9. USB host (PC) not found 10
Figure 10. Manual board connection 11
Figure 11. Board connected successfully 11
Figure 12. Error detection mode performed 12
Figure 13. Connectors, buttons, UART 13
Figure 14. Microcontroller, USB, power supply 14
Figure 15. High brightness LEDs 15
Figure 16. LED drivers 16

2 Board function overview

The STEVAL-ILL028V1 demonstration board features:

- Three STP1612PW05 (QFN24 4 x 4 mm) connected to 16 RBG LEDs
- 16 RGB high brightness LEDs
- One STM32 microcontroller using internal HS oscillator
- An ST1S10: a high-efficiency switching DC-DC power supply
- 7.5 - 18 V DC power supply with undifferentiated polarity and overvoltage protection
- DC input current 0.7 A max., standard supply connector
- LED current regulation
- The board can be controlled by 3 buttons, a knob and a reset/back button
- Test point for each main signal
- Microcontroller firmware update through JTAG interface
- Error LED and overtemperature LED for each LED driver
- 3 jumpers to disconnect the LEDs from the driver to test the error detection mode
- 3 jumpers to enable LED shortage from the driver to test the error detection mode
- Mini USB to connect the board to a PC

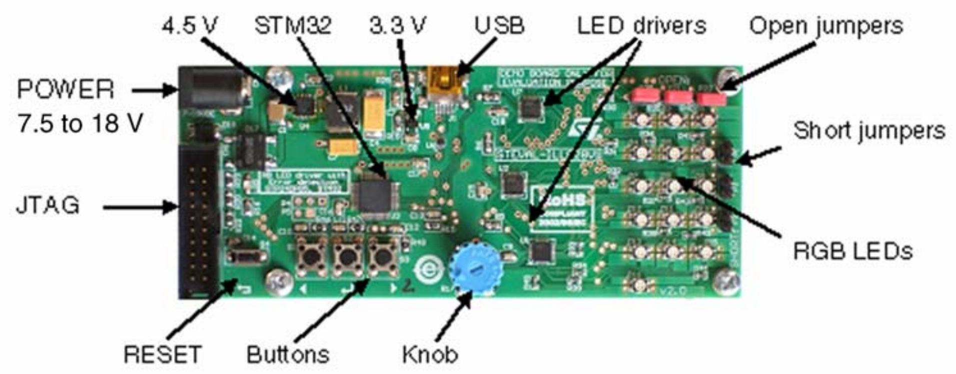
The board is delivered with a firmware allowing to evaluate the board features in standalone and nonstandalone mode:

- LED diagnostic
- Adjustable brightness of each LED
- Adjustable color of each LED
- Animated text
- GUI software for LED diagnostic (see *Figure 6*).

3 Hardware setup

The main board components are shown on *Figure 2*.

Figure 2. Setup of the board



3.1 Power supply

The board is powered by a 7.5 to 18 V DC voltage. The power source must be able to deliver a 0.7 A current. Since the board has a built-in diode bridge, the polarity of the input voltage is not specified.

3.2 Microcontroller JTAG

The board is equipped with a standard 20-pin JTAG connector allowing to debug and develop the STM32 microcontroller.

3.3 Microcontroller clock, reset, USB clock

The STM32 on-board microcontroller uses its internal RC oscillator to generate an 8 MHz clock (that is converted to 48 MHz by a PLL). The clock is also used to drive USB. Since the internal RC oscillator does not allow to achieve the clock stability defined in USB specifications, it is recommended not to use the internal RC oscillator in conjunction with the USB interface. The USB is used only for demonstration purpose, but the performance is limited due to this internal RC oscillator stability.

3.4 Jumpers for LED failure simulation

LED defects can be simulated by using P20, P21 and P22 jumpers:

- Removing a jumper on P20, P21 and P22 causes D1, D2 and D3 green LED open-circuit
- Placing a jumper on P1, P2, and P3 causes D6, D9 and D12 blue LED short-circuit. These simulated defects can be detected during the activation of the error detection mode (see *Section 4*). The defective LED is highlighted by switching on the corresponding red LED.

4 Description of the demonstration firmware functions

The main features of the firmware are:

- Brightness control for each LED
- Color control for each LED
- Error detection to detect LED failure
- Simulation Tetris game.

The RGB LEDs are switched on to display letter 'A', 'B', 'C' or 'D'. Each letter represents a menu option (or mode).

The firmware mode menu items:

- Mode “A” interactive demonstration - color Tetris
- Mode “B” wave color demonstration
- Mode “C” solid color demonstration
- Mode “D” error detection demonstration.

After power-up, the letter 'A' is displayed blinking. An action on a button or on the knob allows to select the required mode and display another letter.

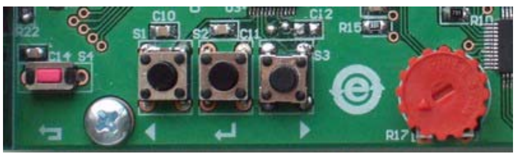
Figure 3. The menu; the letter “A” indicates the first item of the menu



The board can be controlled by four buttons and one knob, *Figure 4*:

- Button back/reset - exit from current task in to the main menu
- Button left - turn the mode menu decrementally
- Button center - enter the choosen mode in menu
- Button right - turn the mode menu incrementally
- Knob - changes the color of the menu from blue to red.

Figure 4. The control buttons



4.1 Mode “A” - interactive demonstration - color Tetris

Mode 'A' performs a simple interactive demonstration similar to Tetris game. The game starts with a green brick moving from the bottom to the top of the LED area. The brick position can be controlled by using the right and left buttons. Once the brick reaches the top of the LED area of another already settled brick, it stops and turns to blue. A blue brick cannot be moved. When a row is full of blue bricks, it disappears and the player scores points. The game ends as soon as the blue bricks reach the bottom of the LED area. When the game is over, the score is displayed. Pressing the center button starts a new game. The knob changes the light brightness of the LEDs.

4.2 Mode “B” - wave color demonstration

Mode “B” shows different color effects. The effect can also be changed manually by using the center button. The knob changes the speed of the effect.

4.3 Mode “C” - solid color demonstration

Mode “C” allows to display a given color on the LEDs. Pressing the right button changes the colors in this order (left button in reverse order): red, green, blue, yellow (red + green), cyan (green + blue), magenta (red + blue), white (red + green + blue) and black (all LEDs are off). The knob changes the light brightness of the LEDs.

4.4 Mode “D” - error detection

Mode 'D' performs LED error detection, and displays the error. Error detection is performed by LED drivers every 2 seconds. If a defective LED is found, it is signalled by switching on the corresponding red LED. D1, D2 and D3 green LED open-circuit defect can be simulated by removing P20, P21, or P22 jumper. D6, D9 and D12 blue LED short-circuit defect can be simulated by closing P1, P2, or P3 jumper.

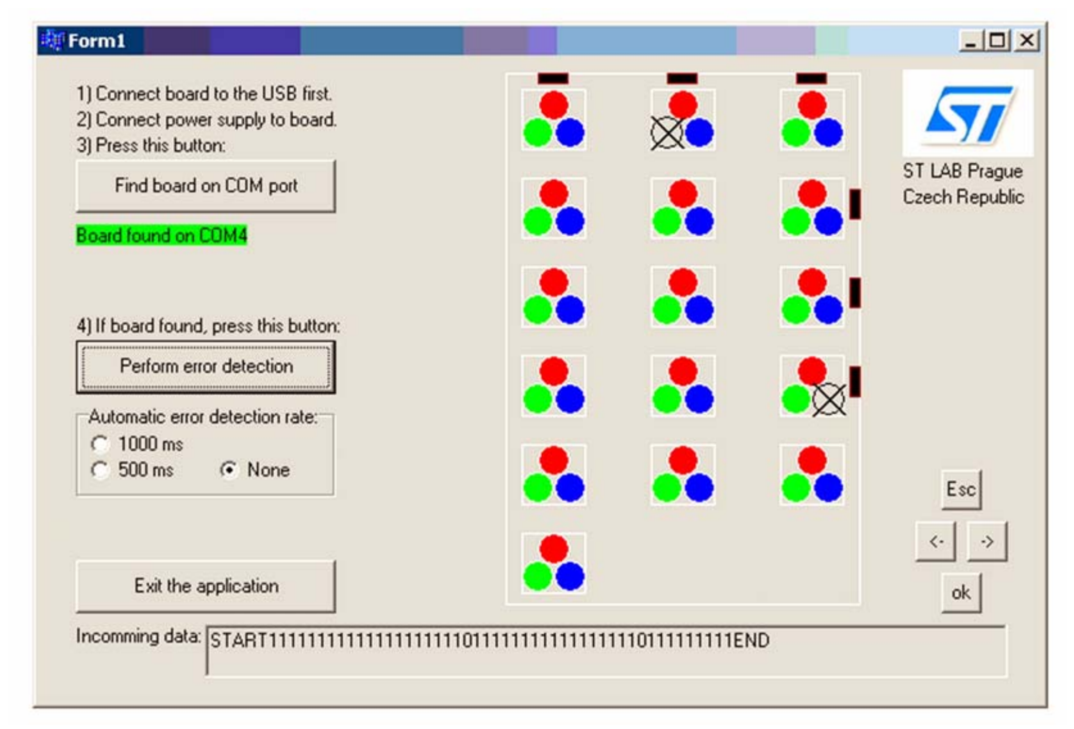
Figure 5. Simulation of LED defect by setting/removing P21 to P2 jumpers



5 PC demonstration firmware software

PC demonstration software supplied with the board can work together with the board firmware using USB interface. The software can detect the board, drive it by mouse instead of the on-board buttons, trigger and visualize the result of the error detection.

Figure 6. Software - Windows® application



The following steps are required to run the PC demonstration software correctly:

1. Disconnect the power supply from the board.
2. Connect the board to the computer through the USB cable.
3. Connect the board to the power supply.
4. If Windows asks for the installation of an appropriate driver, use STMicroelectronics VirtualCOMPort.

Figure 7. USB host (PC) detection in progress

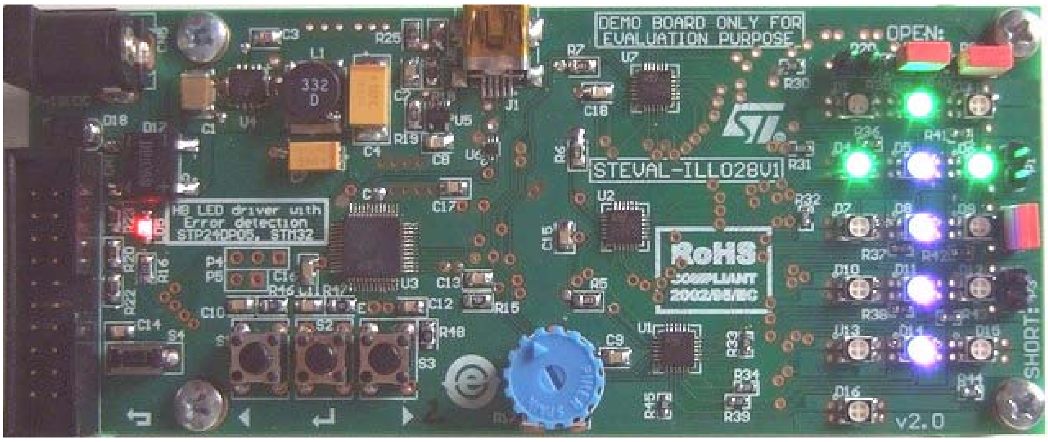


Figure 8. USB host (PC) detected

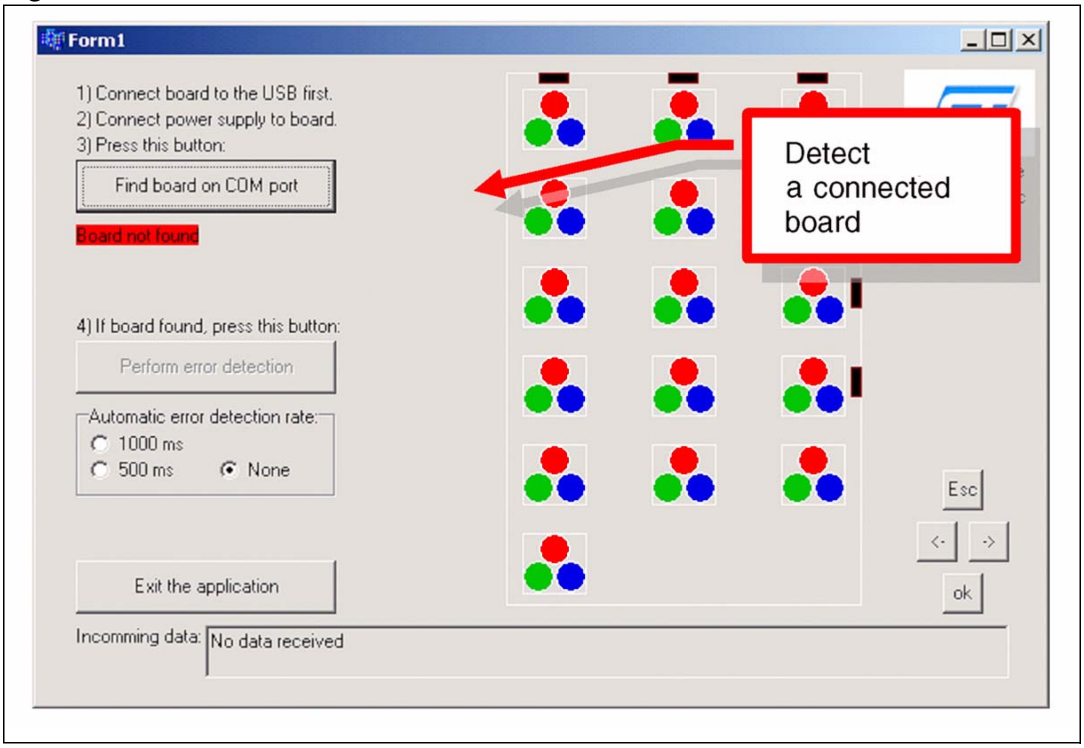


Figure 9. USB host (PC) not found



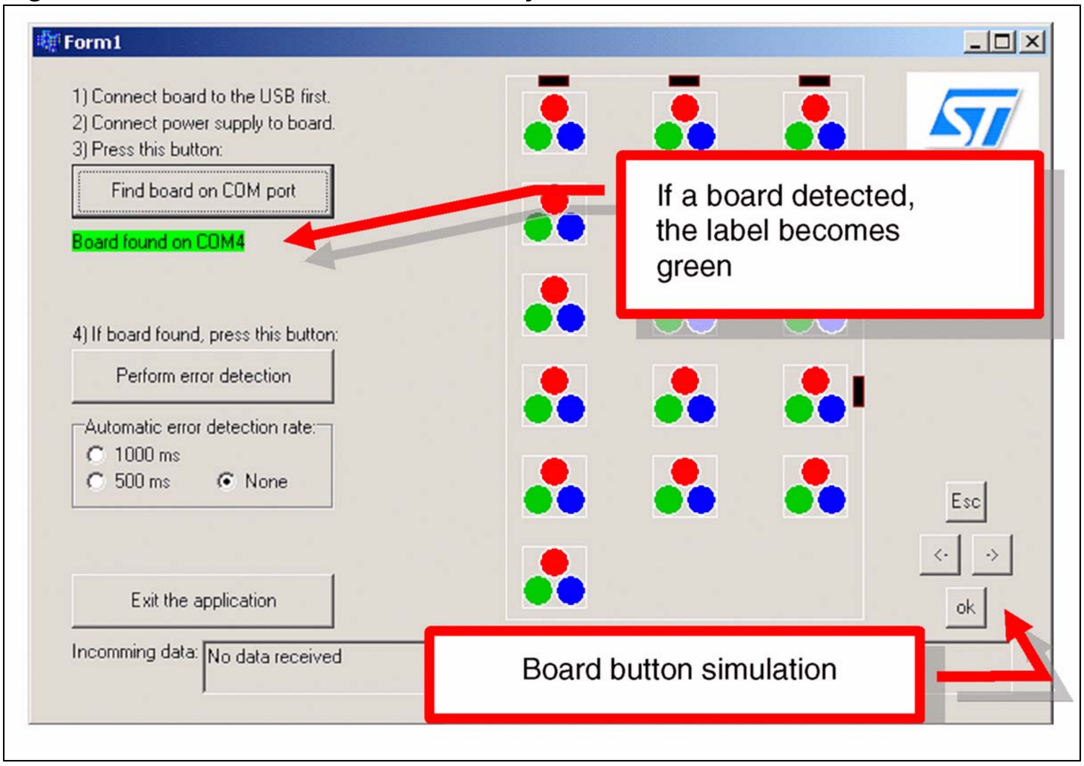
5. Run SWforDimmer.exe.
6. If the board is not detected automatically, click “Find board on COM port” on the menu as shown in *Figure 10*.

Figure 10. Manual board connection



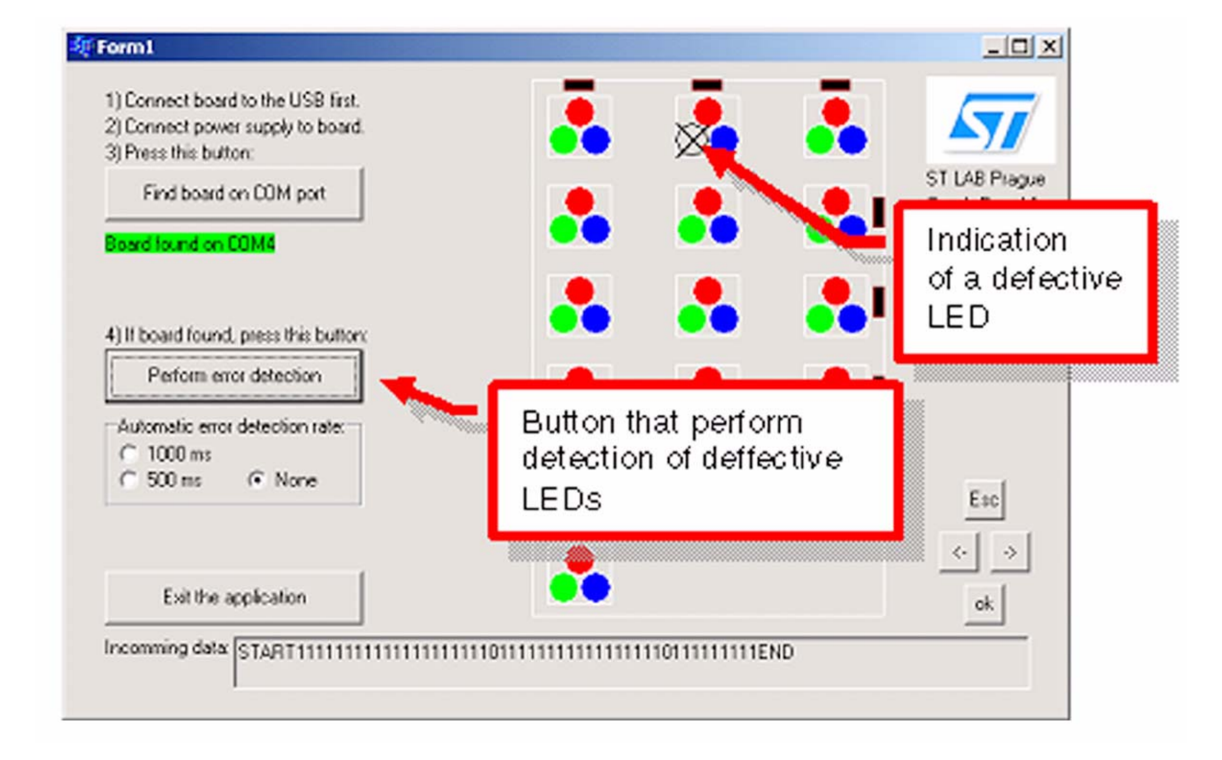
If the board has been found and connected successfully, the message "Board found on COM4" is displayed in green as depicted on *Figure 11*.

Figure 11. Board connected successfully



To perform error detection, click “Perform error detection”. Error detection is performed correctly and does not depend on the board operating mode.

Figure 12. Error detection mode performed



The evaluation of the error detection through the USB interface:

1. Jumpers P20, P21 and P22 are closed and the jumpers P1, P2 and P3 are open, the PC demonstration software will not report any LED defect after clicking ”Perform error detection”. See *Figure 12*.
2. Moving the jumper from P21 to P2 after performing error detection will display the simulated defective green LED on the first row and second column, and the simulated defective blue LED on the third row and third column.
3. Exit the PC demonstration software, and disconnects the board. You can then start testing another board.

6 Schematics

Figure 13. Connectors, buttons, UART

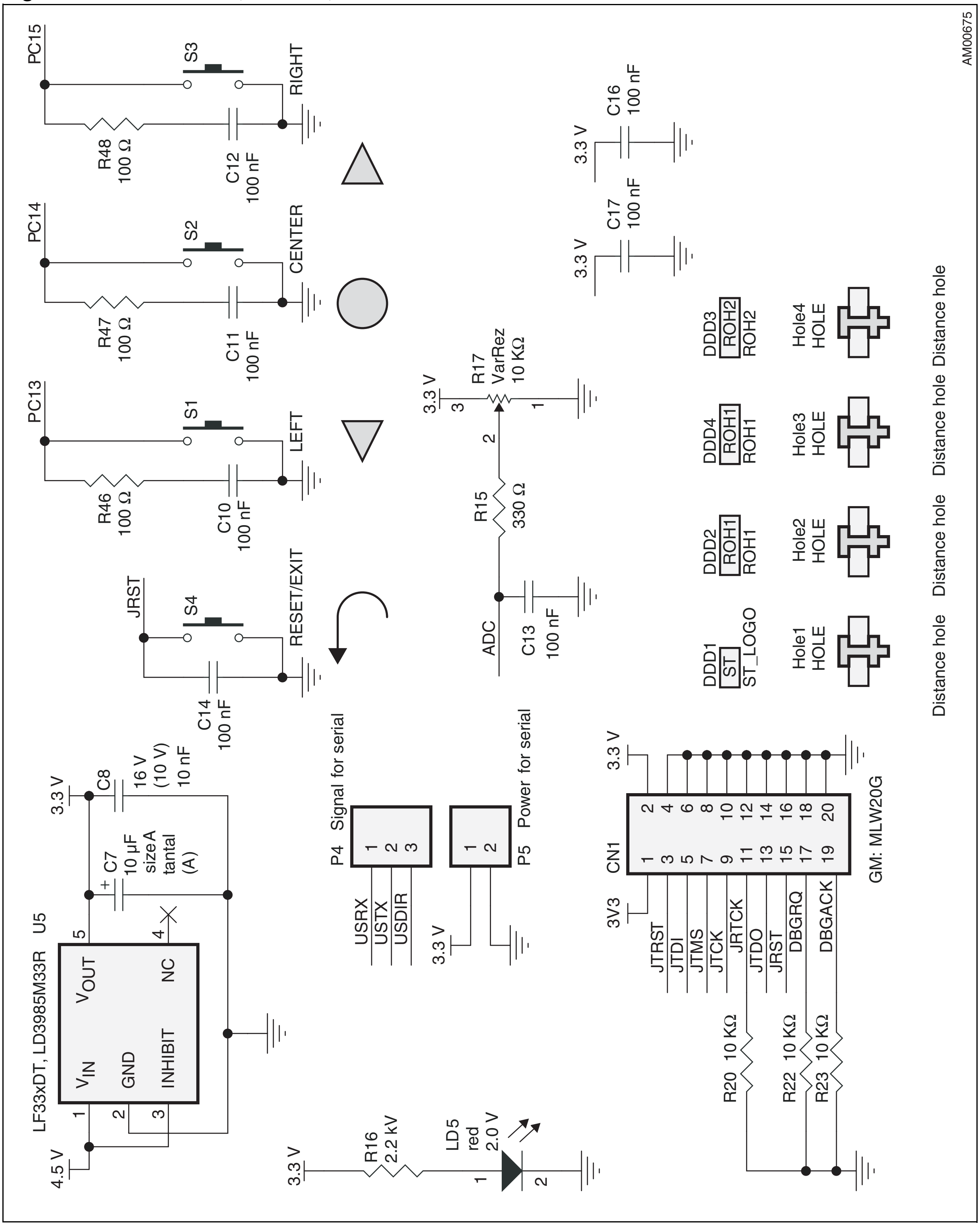


Figure 14. Microcontroller, USB, power supply

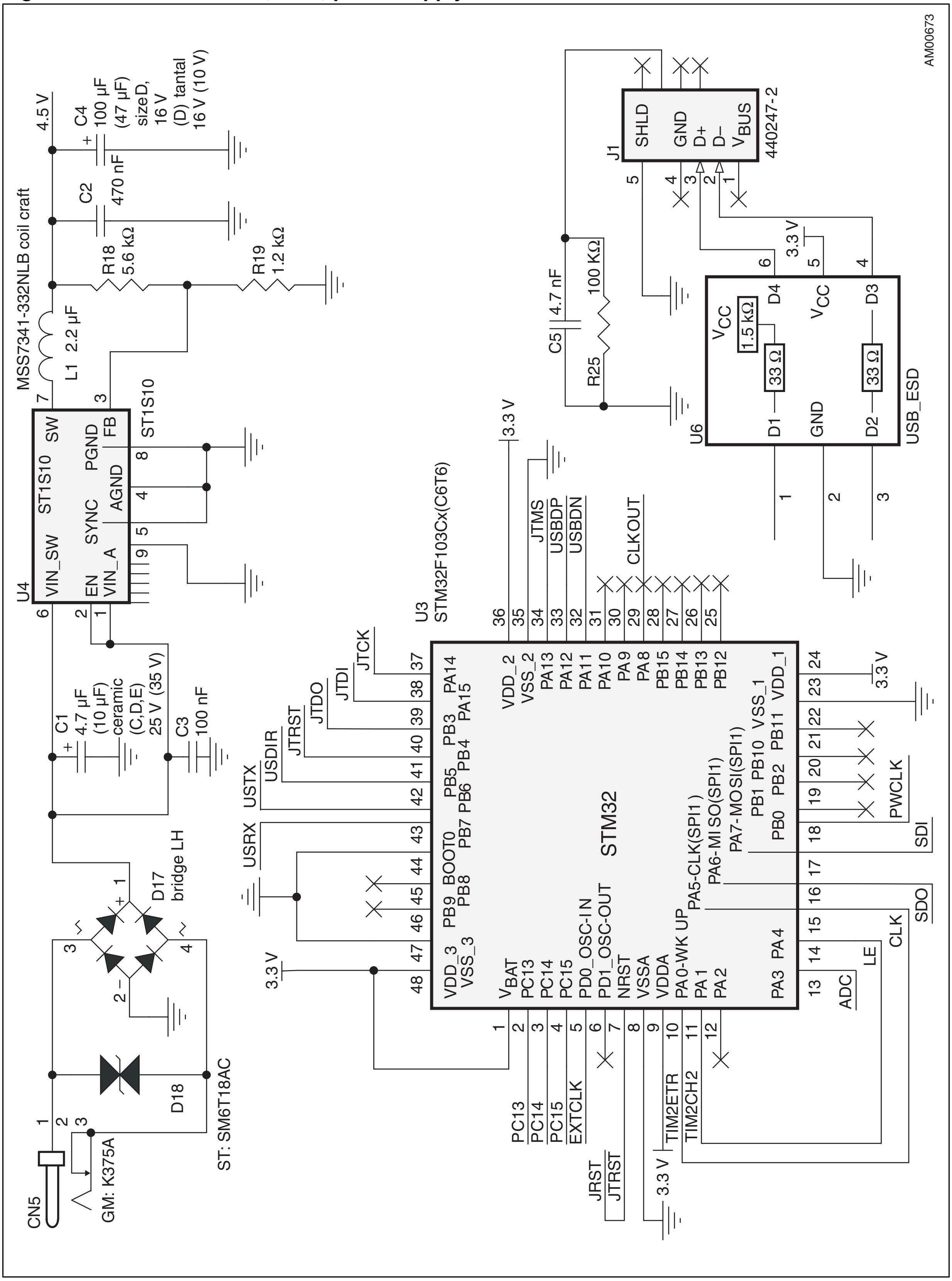


Figure 15. High brightness LEDs

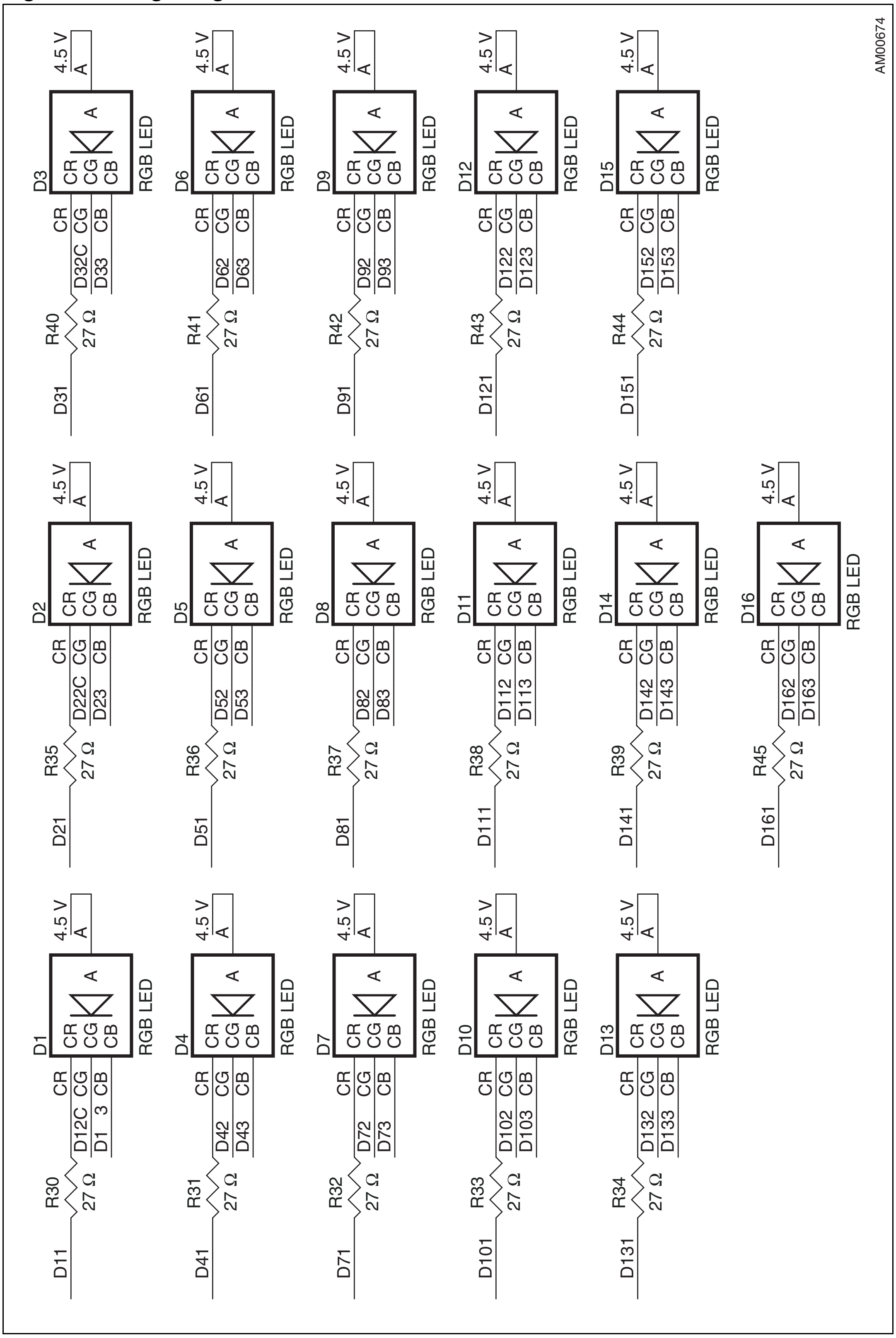
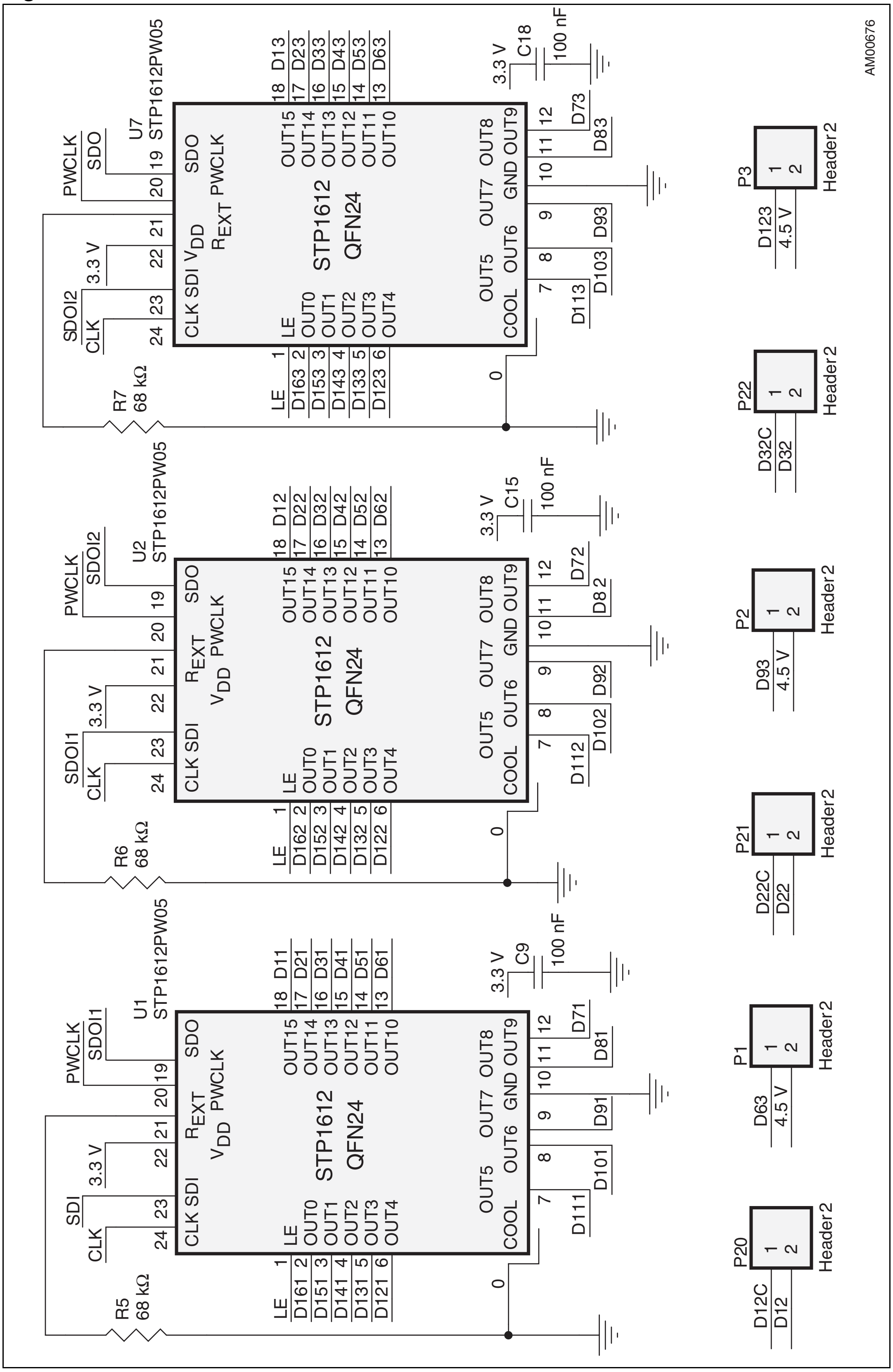


Figure 16. LED drivers



7 Bill of material

Table 1. Bill of material

Reference	Comment	Description	Footprint
C1	4.7 µF (10 µF)	Tantal capacitor polarized	1812LH
C2	470 nF	Capacitor	0805
C3	100 nF	Capacitor	0805
C4	100 µF (47 µF) size D, 16 V	Tantal capacitor polarized	7343_LH
C5	4.7 nF	Capacitor	0805
C7	10 µF size A 16 V (10 V)	Tantal capacitor polarized	3528_ABLH
C8	10 nF	Capacitor	0805
C9 - C18	100 nF	Capacitor	0805
CN1	Female connector with key	Header 10 x 2, JTAG, 10-pin, dual row	HDR2X10keyLH
CN5	Jack input connector	Input power, 4.4V-36V	DC10B
D1 - D16	RGB LED	OSRAM LATB_T686	TOPLED
D17	Diode bridge	Full wave diode bridge	GMBridgeBig
D18	Protection diode	SM6T18AC	SMA
DDD1	ST_LOGO	Label	ST LOGO
DDD2	ROH1	Label	ROH1
DDD3	ROH2	Label	ROH2
DDD4	ROH1	Label	ROH1
hole1 - hole4	Distance hole	Drill	
J1	440247-2	USB 2.0, right angle, SMT, B type, receptacle, 5 position, black	440247LH
L1	2.2 µF	Inductor	Inductor332
LD5	Red	Typical red/amber GaAs LED	D0805LH
P1, P2, P3	Header 2	Header, 2-pin	HDR1X2
P4	Signal for serial	Header, 3-pin	HDR1X3
P5	Power for serial	Header, 2-pin	HDR1X2
P20, P21, P22	Header 2	Header, 2-pin	HDR1X2
R5, R6, R7	68 kΩ	Resistor	0805
R15	330 Ω	Resistor	0805
R16	2.2 kΩ	Resistor	0805
R17	VarRez	Potentiometer	VR5
R18	5.6 kΩ	Resistor	0805

Table 1. Bill of material (continued)

Reference	Comment	Description	Footprint
R19	1.2 kΩ	Resistor	0805
R20, R22, R23	10 KΩ	Resistor	0805
R25	100 KΩ	Resistor	0805
R30 - R45	27 Ω	Resistor	0603LH
R46, R47, R48	100 Ω	Resistor	0805
S1	Left	Button	Button_double
S2	Center	Button	Button_double
S3	Right	Button	Button_double
S4	RESET/EXIT	Small button	Button_DT2112C
U1	STP1612PW05	STP1612PW05 QFN24	QFN24_STP1612PW05
U2	STP1612PW05	STP1612PW05 QFN24	QFN24_STP1612PW05
U3	STM32F103C6T6	Microcontroller STM32	TQFP48
U4	ST1S10	ST1S10	DFN8cool4LH
U5	LD3985M33R	Linear voltage stabilisator	SOT23-5L
U6	USB_ESD	USB signal overvoltage protection	SOT666IP
U7	STP1612PW05	STP1612PW05 QFN24	QFN24_STP1612PW05

8 Revision history

Table 2. Document revision history

Date	Revision	Changes
12-Mar-2010	1	Initial release.
08-Jul-2010	2	Updated *Section 2: Board function overview*.